They burn with a blue flame upon ignition, producing water vapour, carbon dioxide, and hydrofluoric acid. They possess an odour somewhat resembling that of carbonyl chloride. Water dissolves about twenty times its volume of the gas, but the liquid does not mix with water, a very small proportion only being dissolved, and suffering slow decomposition. Alcohol, ether, benzene, and chloroform dissolve it in all proportions.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr. C. Drew; a Grivet Monkey (*Cercopithecus griseo-viridis* ♀) from North-east Africa, presented by Mr. George Conquest; a Grey Ichneumon (*Herpestes griseus*), from India, presented by Mr. J. E. Barber; a Common Fox (*Canis vulpes* ♀), British, presented by Miss Nora Dunn; a Song Thrush (*Turdus musicus*), British, presented by Mr. Baldwin M. Smith; an Alexandrine Parakeet (*Palæornis alexandri* ♂) from India, presented by Mr. E. Bond; two Cerastes Vipers (*Vipera cerastes*) from Egypt, presented by Colonel Holled Smith; a —— Lizard (*Amphibolurus* sp. inc., from Australia, presented by Mr. Herbert E. Swayne; a Guinea Baboon (*Cynocephalus sphinx* ♀) from West Africa, a Rhesus Monkey (*Macacus rhesus* ♂), a Grey Ichneumon (*Herpestes griseus*) from India, two Punctated Agoutis (*Dasyprocta punctata*), a King Vulture (*Gypagus papa*) from Central America, a White-eyebrowed Guan (*Penelope superciliaris*) from South-east Brazil, deposited; a White-faced Heron (*Ardea novæ-hollandiæ*) from Australia, eight Ruffs (*Machetes pugnax* 4 ♂ 4 ♀), British, purchased; a Reindeer (*Rangifer tarandus* ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Photographic and Visual Magnitudes of Stars.—At the Amsterdam Academy of Sciences on April 2, Prof. J. C. Kapteyn communicated the results of an investigation on the systematic differences between the photographic and visual magnitudes of stars in different regions of the sky. The comparison of the photographic diameters of stars of equal visual magnitude (according to Gould and Schonfeld's estimations) on 370 plates of the southern sky, shows that the actinic effect of stars in or near the Milky Way is much greater than that of stars in high galactic latitudes. Prof. Kapteyn has examined the different causes which lead to this variation. There is, first of all, the influence of different meteorological conditions; next, systematic errors in the catalogue of visual magnitudes used for comparison; and thirdly, peculiarities in the light of the stars. The discussion leads to the conclusion that the difference of magnitude is not appreciably affected by the first of these causes. And since, taking everything into consideration, the errors of estimated visual magnitudes could not possibly exceed 0·3 magnitude, there is no doubt that the difference of half a magnitude or more, indicated by the photographs, is due to the quality of light emitted. It is said that Prof. Pickering's idea that the Milky Way ought to be considered as an aggregation of stars of the first type is only sufficient to account for a difference of about 0·1 magnitude. Thus it appears that the light of stars in or near the Milky Way, like those of Group IV., is richer in violet rays than that of other stars.

Photographs of the Lyra Ring Nebula.—In addition to the work on the Carte du Ciel, Prof. Denza, of the Vatican Observatory, has taken up the photography of nebulæ. Beginning with the Ring Nebula in Lyra, he has made five exposures on this object, from half an hour up to nearly two hours' duration. To bring out the fine detail, development has been carried on for about twenty minutes in each case. The negative which had received the longest exposure was presented to the Paris Academy on April 25. Viewed microscopically, the star at the centre of the nebula is seen to be joined to a smaller one near the nebulosity, and each of them can be broken up into other more or less brilliant points. A large number of condensed regions are well visible in the nebula. The location of these leads Prof. Denza to agree with Secchi that "L'anneau se prolonge dans le sens du plus grand axe, et que les parties les plus denses sont dans la direction du petit axe."

Determination of the Constant of Aberration.—Prof. G. C. Comstock contributes the provisional results of a determination of the constant of aberration to the *Astronomical Journal*, No. 261. The method adopted in the investigation is a modified form of that used by M. Lœwy, three reflecting surfaces being placed in front of the objective of the telescope instead of two. Images of stars in different portions of the heavens are thus simultaneously produced in the focal plane of the objective, and a micrometer is used to measure the distance between those of two given stars, when each pair of surfaces is successively employed. Then, if d represent the distance between the images of two stars as measured with the micrometer, Δ the angle subtended at the earth by the stars, R the effect of refraction in changing the true Δ into an apparent Δ′, and K a correction depending upon the squares of the errors of adjustment of the mirrors, we have—

$$\Delta = 120^\circ + \mathrm{K} + d + \mathrm{R}.$$

The provisional value of the aberration constant derived from Prof. Comstock's observations is—

$$20''{\cdot}494 \pm 0''{\cdot}017.$$

An investigation of the refraction has also been made, resulting in the detection of a real variation. The refraction is at a maximum near the time of the winter solstice and a minimum near the summer solstice, but the exact epoch and amplitude have not yet been determined.

Star Magnitudes.—"The Estimation of Star Magnitudes by Extinction with the Wedge," was the subject of an interesting paper by Captain Abney before the Royal Astronomical Society, many of the experiments from which his conclusions were drawn being made from a paper which he and General Festing communicated to the Royal Society on colour photometry. In the experiment for determining the amount by which the intensity of any ray of the spectrum would have to be reduced before it became invisible, the absolute intensity of the D line was fixed upon for the basis, from which all the other intensities could be directly calculated. With the arrangement he described, the D line was reduced to the 350 ten-millionths part of a standard amyl lamp, while under the same conditions the green light E had to be reduced to 65, F to 150, G to 3000, and the red to 110,000 ten-millionths part. By making the rays equal to one amyl lamp the numbers obtained were for D 350, E 35, F 17, G 15, and for C 22,000 ten-millionths part.

These numbers showed that to produce extinction for two lights of equal luminosity, say of colours C and G respectively, the latter was nearly 1500 times greater than that required for the other. He then referred to the extreme persistency of the violet sensations, they being 1500 times more persistent than the red and about 25 times more than the green, pointing out that the violet sensation would be the last to be extinguished. The function of the wedge, then, was not to obliterate the spectrum but to eliminate the violet sensation contained in its light. By determining star magnitudes by this method of extinction, the results obtained, he says, "should agree better with those obtained by photography than those obtained by eye estimation," the first being obtained by estimation of the E light, the second of the light between G and F, and the third from that near D.

Referring to colour extinction he mentions that although most of the faint stars are known to be of a bluish colour it does not follow that "they are not red." The blue tint is brought about by the faintness of the light, which makes all colours appear grey, and "as the violet sensation disappears last, it frequently happens that you get the red and green sensations as grey, and the violet just above the colour limit, thus giving a grey blue." He suggests that with telescopes of large aperture these stars might be seen in colours.

THE INSTITUTION OF MECHANICAL ENGINEERS.

An ordinary general meeting of the Institution of Mechanical Engineers was held on the evenings of Thursday and Friday of last week. There were two items of exceptional interest on the programme, the first being the inaugural address of the new President, Dr. William Anderson, F.R.S.; and the second the report of the Committee appointed by the Institution to make trials on marine engines. The President in his address gave a brief review of the progress of the Institution since its foundation in 1847. For the first thirty years of its existence the Institution was a provincial Society, having its head-quarters in Birmingham. In 1877 it was determined to remove to London, as it was thought that the wealth and influence that had been acquired was sufficient to give a position of national importance which could hardly be held by a Society having its head-quarters in any other city than the metropolis. There was naturally a strong opposition to the migration, but the change was made, and since then the importance of the Institution has gone on steadily increasing, until at the present day it is second only to the Institution of Civil Engineers. The Institution was started in 1847 with 107 members, the annual income being £515. During the first thirty years the membership increased about tenfold, but at the end of the fourteen years that the head-quarters have been in London it has increased to twenty-fold; that is to say, in 1877, when the migration was made, the numbers were about one thousand, whilst last year they were over two thousand—actually 2077. The annual income was last year £7212, and the accumulated investments of the Institution are now £22,536.

A somewhat acrimonious correspondence has been published lately in the pages of a weekly journal, and the President, somewhat unnecessarily perhaps, thought fit to reply to this. A complaint had been made that the papers were few and poor. Dr. Anderson referred to the large number of scientific Societies now existing, and the difficulty of providing good papers. "We have been spoiled and cloyed," he says, "by the rapid progress of mechanical engineering; so that papers which are not revelations of something new are condemned as unworthy of the Institution. Is there any form of steam-engine, for example, which it would be worth while now to describe, unless it be some monster of exceptional proportions, the details of which we should like to see in our Transactions? Who would like to read a paper on a bridge of even 800 feet span, and to illustrate it with all the type and plates which characterized the two accounts of the Britannia Bridge, when the Forth Bridge, a structure of more than double that opening, has recently become familiar to us? I am afraid that, in consequence of the state at which we have arrived, and, in respect of originality, the untoward age in which we live, we must be content with many papers that may justly be termed poor so far as novelty alone is concerned. We must, therefore, rely for excellence on a more scientific treatment of our subjects, and on the care with which the details of construction are worked out and presented in the illustrative drawings. Our critics should remember also that originality is not our only quest—that we are not all veterans to whom design comes almost by instinct: we have a large body of younger and less experienced members, and to them I feel sure, from my past experience, that our proceedings offer practical examples and guidance which are appreciated all over the world, and the desire to possess which is, I take it, the main cause of the ever-increasing strength of the Institution."

The President next referred to the work done by the different Research Committees of the Institution which have been engaged for some years past in investigating engineering subjects upon which information appeared most desirable. There have been Committees on riveting, on friction, on steam-jacketing engine cylinders, and other matters, including marine-engine trials, the last report of the Committee on the latter subject having been presented at the meeting now under notice. It would be difficult to imagine a more useful and legitimate purpose upon which the funds of the Institution could be spent. The work that is over and over again done, generally in a partial and imperfect manner, by private firms, in getting information on many points of engineering practice, represents a sad loss of time and money. The work of the Research Committees of the Institution should put an end to a great deal of this, and will so help the advance of engineering practice, to the benefit not only of engineers, but of the whole civilized world. The President made another suggestion which would tend to the same end, and which it is hoped may be carried out. "There is," he said, "another sphere of usefulness in which our abundant means would enable us to do good service; it is in the compilation of a brief reference index to all mechanical matters at home and abroad. Were we to establish a staff—and it might be a very modest one—whose duty it would be to index under proper heads every important article relating to mechanical science which comes out week by week, we should in time, and at moderate cost, form an invaluable record, from which an inquirer would be able to find in a few minutes where to look for complete information on any subject connected with our special branch of engineering." The Royal Society is doing a similar work for scientific papers generally; and in the United States Messrs. Haferkorn and Heise have compiled a most useful index of books printed in English relating to technical matters, but the work stops at 1888, and does not contain references to the isolated letters and papers which appear in English and foreign journals.

Dr. Anderson, as every one knows, holds the important post of Director-General of Ordnance Factories, and it was natural he should make some reference to the various establishments—the chief of which, of course, is Woolwich Arsenal—under his control. Here, again, public criticism has been exercised of late, not altogether favourably, and a good part of the address was taken up with an apology for Woolwich. Taking the side of the case selected by Dr. Anderson for discussion, there is no doubt he made out a very good case. It is perfectly impossible that all inventions should be adopted, and therefore it is evident the authorities with whom these matters rest must reckon with a great many hostile critics. The address gave some interesting details of the way in which the Ordnance departments are managed, but into this question we need not now enter. The difficulty of finding subjects for papers which were altogether novel had been previously referred to in the address; but, notwithstanding that there is little scope for originality, Dr. Anderson pointed out that some problems still remain to be solved. Among them is one which is of the greatest practical importance to mechanical engineers, while at the same time it is of extraordinary theoretical interest. This was the question of the nature and composition of steel, and alloys generally. Since the year 1879 the Institution had been engaged in trying to unravel the mystery which surrounds the behaviour of steel in connection with its chemical and molecular composition, combined with changes of temperature. The researches of Sir Frederick Abel, Dr. Sorby, Mr. Osmond, Mr. Hadfield, and Prof. Roberts-Austen, aided by the Le Chatelier pyrometer, have given the inquiry new life. Dr. Anderson expressed great hope that the active measures taken by the Institution, through the Alloys Research Committee, would result, at no distant time, in the solution of the enigma, and in the establishment of definite laws. The problem, however, is excessively involved. It amounts, in fact, to a consideration of the number of permutations or combinations possible among some ten variables, the relations of which to each other are also dependent, not only on actual temperature, but also on the rate of its changes, and on the uniformity of these changes, throughout the mass. The address next made reference to the fact that pure iron is allotropic, and exists in both the hard and soft state. Carbon also exists in two forms in steel, either combined or suspended in the mass; and there are other ingredients necessary to take into account. In consequence of changes due to temperature also, the chemist is impotent to pronounce from mere analysis what the quality of steel may be. On the other hand, the ordinary mechanical tests are not of much avail, because the specimens are not and cannot be in the same condition of internal stress—on which again the molecular arrangement appears to depend—as the masses from which they are cut. Moreover, specimens for mechanical testing cannot always be taken from the central parts of the huge forgings and castings now in use for many purposes. Under these circumstances Dr. Anderson considered that the method of noting the rate of cooling by curves automatically traced—as now so ingeniously worked out by Roberts-Austen—affords the best promise of placing in the hands of the mechanic a means of judging at any rate of the uniformity in composition of the material, and even perhaps of its actual chemical nature, so far as this affects his wants. As additional advantages the thermo-electric autographic apparatus is cheap; it occupies but little space, it can be employed in an ordinary room, and the results sought can be obtained in a few minutes.

The use of petroleum or mineral oil next occupied a place in the address, the author being of opinion that as a source of power it would rapidly gain ground. In 1888, Priestman Bros. brought out their engine, working with a heavy oil having a high flashing temperature. That engine was tested by the present Lord Kelvin (then Sir William Thomson) and the author independently, and gave an efficiency of one brake horse-power to 1·73 lb. of oil. At the next year's show the consumption fell to 1·42 lb.; in 1890, to 1·243 lb., and Prof. Unwin this year reports that a brake horse-power has been obtained by the combustion of 0·946 lb. Much yet remains to be done. The useful work on the brake is under 14 per cent. of the energy latent in the fuel, while the heat carried off by the water jacket round the cylinder, and by the exhaust is equivalent to 75 per cent. of the total thermal capacity of the fuel. Dr. Anderson was of opinion that a combination of the direct combustion engine with the spirit-engine of the Yarrow type would give the best results, especially if a more advantageous cycle than that of the Otto gas-engine can be adopted.

The address next proceeded to deal with the question of the capacity of the earth to supply the ever-increasing demand for petroleum, and to enquire whether it would be possible to substitute it largely for coal as a source of heat, owing to the fact that we should have to go deeper and deeper in the future to reach workable coal measures. In connection with this problem the address gave particulars of the researches of Mendeleeff, and described his theory of the continuous formation of petroleum by the action of water on the molten rocks in the interior of the earth. The speculation is one of great interest, but has already been dealt with in these pages.

The vote of thanks to the President for his address was moved by Sir Frederick Bramwell and carried with acclamation.

After the reading of the address the Report of the Marine Engine Trials Research Committee, which had been prepared by the Chairman of the Committee, Prof. Alexander B. W. Kennedy, was read. This report dealt with the trials of the Belgian channel steamer *Ville de Douvres*, which had been generously placed at the disposal of the Committee by the Belgian Government. This vessel is one of the line which carries the mails between Ostend and Dover, and was built and engined by the Société Cockerill, of Seraing, Belgium, and is a comparatively new vessel, having been delivered in the year 1890. The propelling machinery consists of a pair of compound surface-condensing paddle engines. Vessels of this class are mainly designed with a view to speed, as the chief object desired is to carry passengers and mails quickly from port to port. As the run is only of three hours' duration, it would obviously not pay to enter into any refinements with a view of economizing fuel. The time under way is comparatively small when considered in relation to the time spent in raising steam and cooling down again. This is a point which should be borne in mind, but which some critics appeared to forget during the discussion. Perhaps engineers are apt to base their estimates of efficiency, especially in marine practice, too much on an economy basis. It is a good thing to save fuel if it can be done without too much sacrifice. An examination of the details of the various trials of steamships made by the Research Committee illustrates this important point. We hardly know how to deal with this paper. It is full of information of the most valuable description, but its very fullness renders it extremely difficult to make an abstract, and we have not space to give all the details in full. Perhaps the best plan will be to give some of the leading facts; and, although these may appear somewhat bald standing alone, they will enable our readers to form an estimate of the scope of the trials, and those who are especially interested will go to the original, in the Transactions of the Institution, for fuller details. The *Ville de Douvres* is 271 feet long, 29 feet broad, and 15·5 feet deep, moulded. Her registered tonnage is 855 gross; and her displacement 1090 tons. She was run for nine hours especially for the trial in the North Sea. The engines are of the compound, inclined, surface-condensing type, with cylinders 50·12 inches and 97·12 inches in diameter, with 72 inches stroke. Neither cylinder is steam-jacketed, but there is an intermediate receiver encircling the high-pressure cylinder; an arrangement which certainly does not tend towards efficiency. The air, feed, and bilge pumps are driven from the main engines. The circulating pump is separate, and is estimated to develop 47 indicated horse-power. The surface condenser contains 6540 square feet of tube surface, and it is so arranged that the circulating water passes three times through the condenser. The course of the water is such that the coldest water meets the hottest steam. This is naturally not the best arrangement, for the circulating water would still be efficient for taking heat from the hottest steam, even after it had been somewhat raised in temperature by the coldest steam. On the other hand, circulating water having been heated by the steam at highest temperature, will be comparatively inefficient to further cool down steam already cooled to a great extent. In any case, if a good vacuum be ultimately obtained, the refrigerating surface will be far less effective. The paddle-wheels are 22 feet 10 inches over the floats, the latter being 10 feet broad and 4 feet 4 inches deep. The immersion on trial was 17 inches. There are four single-ended return-tube boilers, 13 feet by 10 feet. The grate area is 236 square feet, and the total heating surface 7340 square feet. There is forced draught on the closed stokehold system. The total weight of all machinery, exclusive of paddle-wheels, and all water is 361 tons. Block fuel was used throughout the trial. The calorific value, calculated from analyses made, was 14,390 thermal units per pound. This corresponds to an evaporation of 14·90 pounds of water from and at 212° F. A number of samples of furnace gases were collected and analyzed, with the following mean results:—

	Carbonic Acid.	Carbonic Oxide.	Oxygen.	Nitrogen.
By volume per cent.	11·55	0·00	7·95	80·50
By weight per cent.	16·84	0·00	8·44	74·72

There was a little uncertainty about the temperature of the chimney gases, but the mean temperature was assumed to be 910° F. The mean draught was equal to a pressure of from 0·92 to 1·22 inches on the water-gauge. A notable feature about these trials was that the feed measurement was made by meters. This is a vast improvement, in one respect at least, and that of great importance, on the measuring tank system. Measuring tanks are always cumbersome and difficult to fit; so much so that they generally prove the greatest bar to proper trials being made of the efficiency of marine machinery. The meters used were of the Kennedy type, and appear to have answered the purpose admirably. There is no trouble in taking a meter reading, whilst the measuring tanks require constant attention. We look on the introduction of the water meter for this purpose as a most important step in advance, and one which will lead to engineers obtaining more frequent information on the efficiency of marine engines. It is most desirable that the performance of the boiler should be separated from that of the engine. The indicated horse-power and coal consumption give the economy of the whole machine; but when results are not satisfactory it is often difficult to say whether the fault rests in the boiler compartment or the engine room. Another step in advance is the effort made to measure the amount of priming water. In the present day we do not have so much trouble from priming as in past times, when lower pressures were in use and the steam space was practically what it is now. Still, there are yet large quantities of unevaporated water often carried over to the engines by the rush of steam. It is obviously useless to exercise great care in measuring the feed if a considerable part of it is carried from the boiler to the condenser simply as water. In such a case the boiler is credited with a high evaporative efficiency by reason of its very fault; and the engine is debited with steam which it never receives, but on the contrary is having its action impaired by the presence of water in the cylinders. The method of testing for priming is as follows:—A quantity of steam from the main steam-pipe is condensed in a special surface-condensing apparatus, and collected, and at the same time a sample of water is taken separately from the boilers. Both of these samples are carefully analyzed to determine the quantity of salt present in each. As the whole of the salt found in the sample from the steam-pipe must have come over from the boiler in conjunction with priming water, and not with steam, a simple calculation will show how much boiler water corresponds with the quantity of salt, if any, found in the steam-pipe sample. From this it is easy to determine what percentage of the whole feed-water has passed from the boilers in the form of water, or, in other words, what percentage there is of priming. The chemical determination for salt is a very simple one, and is capable of being carried with ease to an exceptional degree of certainty. The observed and calculated data of the trial are given in a full table appended to the report. The mean boiler pressure was 105·8 lbs. above atmosphere, the vacuum 10·12 lbs. below atmosphere, the revolutions 36·82 per minute, the mean indicated horse-power 2977, the fuel per square foot of grate per hour 31·3 lbs., and the feed-water per indicated horse-power per hour 20·77 lbs., allowing for auxiliary engines. The efficiency of the boiler was 66·1 per cent., and of the engines 11·7 per cent. The combined efficiency of engine and boilers was 7·7 per cent.

A very interesting discussion followed the reading of the report, but a great part of this it would be useless to give, as many details of the trial have necessarily been omitted from our brief abstract.

A paper was next read "On Condensation in Steam-Engine Cylinders during admission." This was a contribution by Lieutenant-Colonel English, of Jarrow. In former papers on this subject the author had given experimental data, but it was objected that he had left out of account the range of temperature in the cylinder. In order to show that this was not the case, he submitted the following formulæ, which, he claimed, proved his case. The former papers, a study of which is necessary to a proper understanding of the facts, may be found in the Transactions of the Institution for the years 1887 and 1889.

In jacketed cylinders the weight of steam condensed per stroke and not re-evaporated at cut-off is represented by the expression

$$\frac{56}{\sqrt{\text{revs. per second}}} \times \frac{(S_c - S_1)}{L}\rho_1,$$

where S_c is the unjacketed clearance surface in square feet, S_1 the fresh surface exposed during admission up to cut-off, ρ_1 the initial density of the steam in pounds per cubic foot, and L the latent heat of evaporation in thermal units. If d be the diameter of the cylinder in feet, l the length of stroke in feet, m the proportion of stroke up to cut-off, $\mu = \frac{S_c}{2 \times \text{area of cylinder}}$, and N the number of revolutions per minute; then S_c = unjacketed clearance surface $= \frac{\mu\pi d^2}{2}$; $S_1 = \pi dml$; $\sqrt{\text{revs. per second}} = \frac{\sqrt{N}}{7{\cdot}75}$; and the foregoing expression may be written

$$\text{Weight condensed} = \frac{56 \times 7{\cdot}75}{L \times \sqrt{N}}\left(\frac{\mu\pi d^2}{2} - \pi dml\right)\rho_1$$
$$= \frac{868}{L \times \sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right)\frac{\pi d^2 ml}{4}\rho_1.$$

But $\frac{\pi l^2 ml}{4}\rho_1$ is the weight of steam per stroke uncondensed at cut-off, and 868 may be taken as an approximate value for L; therefore for jacketed cylinders;

$$y = \frac{\text{weight condensed}}{\text{weight uncondensed}} = \frac{1}{\sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right).$$

For unjacketed cylinders a similar approximate expression is

$$y = \frac{1{\cdot}5}{\sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right).$$

The author supported his views by means of a voluminous table, in which he gathered together the observed data on a number of steam-engine trials made by various well-known authorities, to which he attached the results obtained by calculation on his system.

A short discussion followed the reading of this paper, and the meeting was then brought to a conclusion by the usual votes of thanks.

The summer meeting of the Institution will be held at Portsmouth, on July 26 to 29.

THE ROYAL SOCIETY SOIRÉE.

THE annual *soirée* of the Royal Society, which took place on Wednesday, May 4, may be said to have been the most successful that has been held for many years. All the necessary arrangements, which were by no means few in number, were carried out without a hitch, while the exhibits were of a most attractive nature. As regards the latter, the following are a few notes of the most novel and important objects displayed:—

Prof. T. E. Thorpe exhibited a model to illustrate the general phenomena of explosions as brought about by the presence of dust particles, in explanation of the causes of colliery explosions. This apparatus consisted of two long narrow boxes, fitted together in the form of a cross. On the bottom of these boxes was thinly strewn a quantity of fine Lycopodium powder, while at one end of the longer box there was a small chamber in which a blank cartridge was fired. The firing of this cartridge corresponded to the direct action of a "blow-out shot," while the dust raised by the concussion, which carried the flame throughout the entire apparatus, took the place of the fine coal dust. The apparatus also showed that the progress of such an explosion was always accompanied with increase of violence.

Prof. Clowes showed an ordinary miner's safety-lamp which had, by a very simple contrivance, been converted into a delicate instrument for detecting minute proportions of fire-damp. To the ordinary burner an additional tube is made to pass through the oil reservoir, one end of it being connected, by means of a flexible tube, with a small portable bottle of compressed hydrogen. The hydrogen when turned on becomes ignited close to the oil burner, the flame of which is extinguished by turning down the wick; by adjusting the flame of hydrogen to the standard height, a luminous column of light is seen vertically over it, from the behaviour of which the amount of inflammable gas can be directly estimated. At the conclusion of the experiment the wick is simply turned up, and ignited from the hydrogen flame; the latter is then disconnected from the bottle. From 0·25 to 3 per cent. of fire-damp has in this way been estimated, while greater quantities than these have been measured by reducing the size of the flame.

Vacuum tubes without electrodes, exhibited by Dr. Bottomley. These tubes, which were of a variety of shapes and kinds, illustrated very beautifully all the phenomena of stratification. They were sensitive also to magnetic and electro-dynamic influence, and showed the phenomena of molecular bombardment. The brilliant illumination of a piece of Iceland spar contained in a glass sphere afforded an excellent means of displaying the electrical excitements. [For an account of experiments with vacuum tubes, see a letter by Mr. Bottomley in NATURE, January 6, 1881, vol. xxiii. p. 218.]

Mr. Cecil Carus-Wilson exhibited some natural and artificial sands, from which he was able to produce many musical notes. These notes, as he explained, were the results of the rubbing together of the surfaces of the grains of sand, but he had met with several sands from which he could not obtain a vestige of a note. One special artificial sand sang only when rubbed in some sort of vessel.

Apparatus for measuring degrees of incompleteness of colour vision, exhibited by Mr. Brudenell Carter. The object used for the tests is a group of various colours, which were such that they could be seen by either reflected or transmitted light. The amount of illumination that was required to recognize the colours distinctly was a measure of the "degree of incompleteness." In order to control this amount of illumination, light of known intensity had to pass through a variable aperture before it fell on the test object, the size of this aperture being read off in square millimetres.

Captain Weir's azimuth diagram was exhibited by Mr. J. D. Potter. It is claimed for this diagram that besides being most ingenious, it furnishes one of the most successful modes of graphic solution of a mathematical problem that has ever been invented. It is used for finding the true azimuth of a heavenly body, taking into account the ever-changing errors of the compass, which in our days of iron ships have to be so carefully watched and recorded. The errors as usually determined are obtained from observations made of the compass-bearing of a heavenly body (the sun generally being taken) with its true bearing, and it is for the simplification of this method that this azimuth diagram has been found to be practically useful.

Prof. Oliver Lodge had three exhibits. The first was the projection of interference bands on a screen, being produced by a modified method of Michelson. Very striking also were the electric sparks in and to water, illustrating lightning effects and multiple flashes. In a shower, with too great spark-length for a strong discharge, a multitude of violet streams or spurts filled the air, resembling somewhat lightning flashes. The spark to water spread itself out over the surface, showing that the surface layer was a feeble dielectric, while the spark under water was brief but very violent, treating the water as a dielectric, and producing concussion. The electric retina, illustrating the possible meaning of the rod-and-cone structure, was very interesting; radiation from spheres which were in a suddenly disturbed and oscillatory electrical condition falling upon a graduated series of end-on cylinders, which responded by vibrating transversely.

Mr. W. Crookes repeated many of those beautiful experiments of electric currents of high potential and extreme frequency that were first carried out by Tesla. The discharges from a battery of Leyden jars were sent through the primary